# Different Approaches to Manga Colorization

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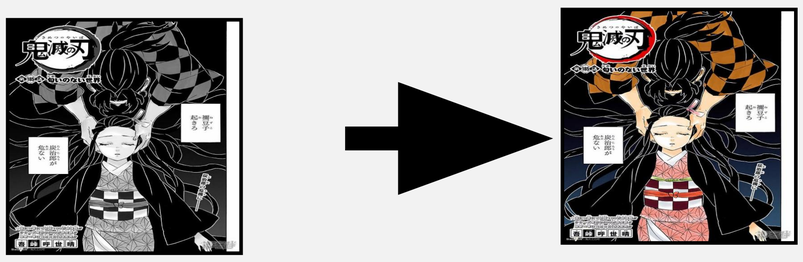
## Goal: Manga Colorization

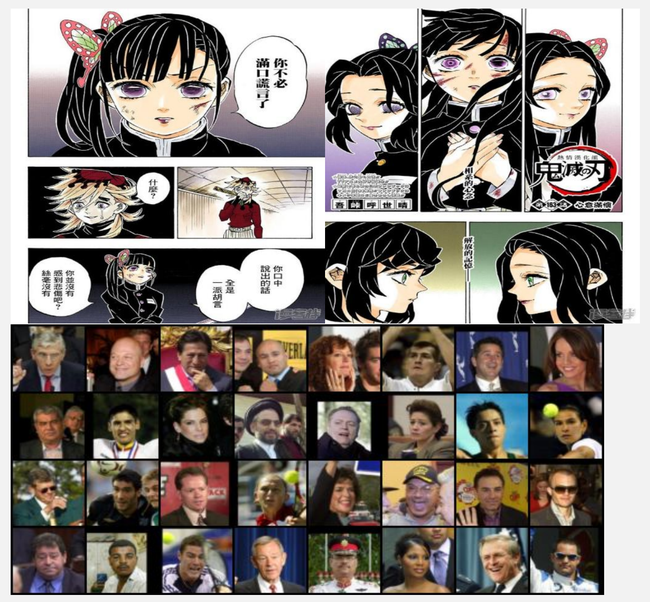


**Motivation:** The work of animators is heavy. Could it be possible for computer to generate colored manga images out of black-and-white versions?

## Data

**Data**: Kimetsu no Yaiba
**Size**: 174
**Source**: Crawling

**Data**: Aligned facial images
**Size**: 13233
**Source**: Labelled Faces in the Wild dataset (LFW)



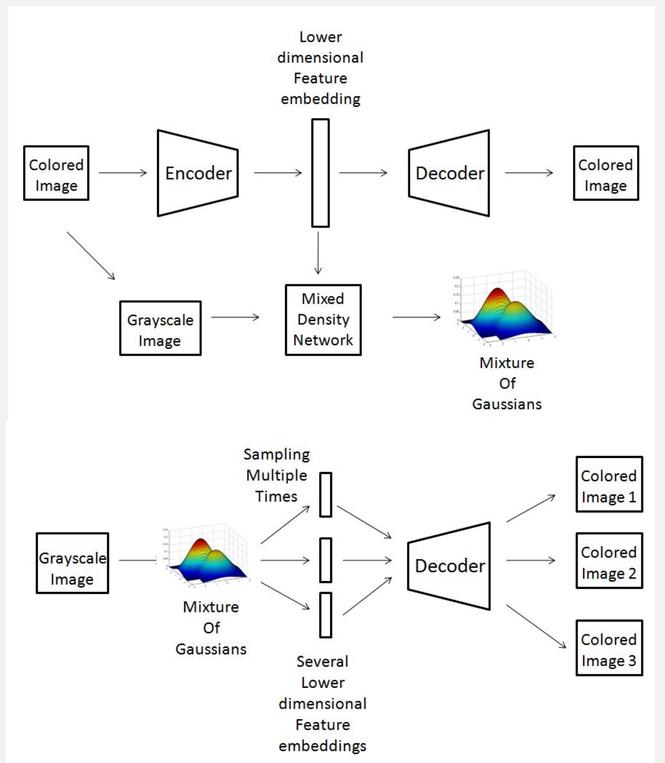
## Method 1 VAE + MDN Colorization

### The training process:

1. We train a variational autoencoder on colored images, and generates their feature embeddings in low dimensions.
2. We use a Mixture Density Network to model the conditional distribution of lower-dimensional embeddings over original grayscale images as a mixture of Gaussian distributions. Thus, sampling from the MDN network can generate different feature embeddings out of the same grayscale image.

### The testing process:

Sampling from the conditional model and then going through the decoder to general several plausible colorization outputs from one grayscale input.



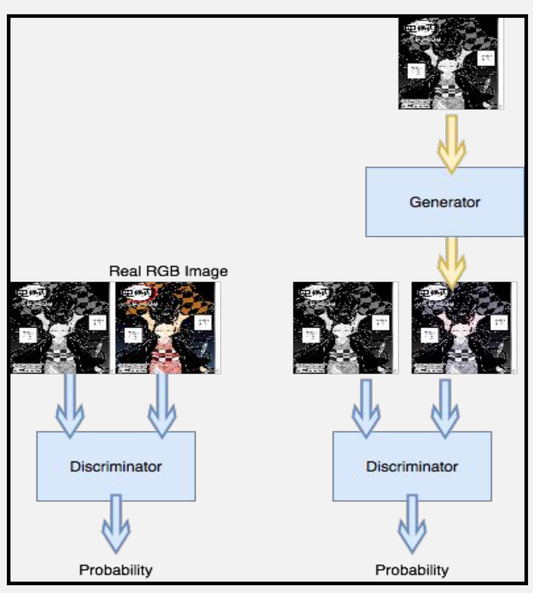

## Method 2 cGAN-based Colorization

### The training process

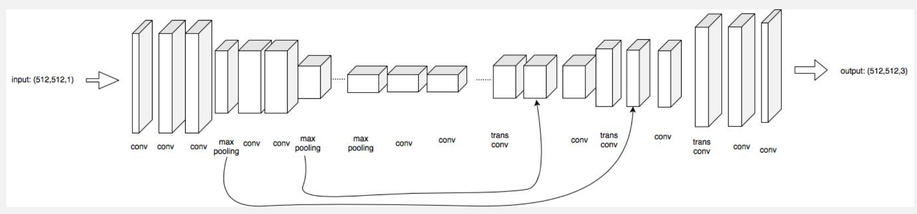
1. The cGAN model is conditioned on the gray scale image.
2. The generator is a conv-deconv neural network, aiming to generate a vivid RGB image indistinguishable from the real one.
3. The discriminator contains conv layers, aiming to distinguish between the real and generated RGB image.

### The testing process:

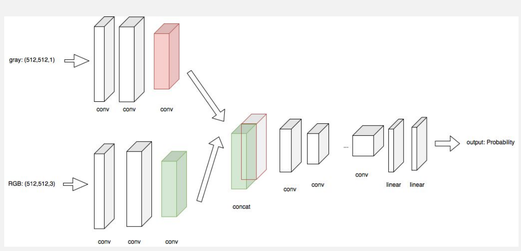
Use the generator to produce RGB images from the grayscale inputs.




## Generator

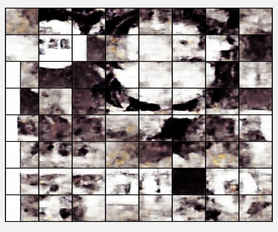



## Discriminator:




Original

VAE+MDN result:



cGAN result:

## Results

For loss, we use 0.8*quantitative loss (L2) + 0.2*qualitative loss (0-10 human scored)

| cGAN loss | VAE+MDN loss |
|---|---|
| 386 | 4606 |

In conclusion, we compared two methods, VAE+MDN and cGAN, for colorizing mangas images. We found cGAN produced ones to be more promising. In the future, we hope to find a way to modify the cGAN approach so that it will turn the manga images into into different style (e.g.vibrant, gloomy, etc.).